

Will This Patient Tolerate a Pneumonectomy?

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OBJECTIVES

1. To appreciate recent advances in the preoperative assessment of patients for major pulmonary resections. To know which tests have been shown to be valid predictors of outcome.
2. To understand the specific intraoperative anesthetic management issues that are relevant to patients having pneumonectomies.
3. To review the anesthetic management of life-threatening complications which may occur in the post-pneumonectomy patient.

STEM CASE - KEY QUESTIONS

A 69 year-old male is seen in the Anesthesia Preoperative Assessment clinic for evaluation prior to a possible right pneumonectomy. He was found to have a right upper lobe mass lesion on X-ray following treatment for right upper lobe pneumonia 4 weeks previously.

He is a current smoker with a 50 pack-year history. He gets short of breath climbing 2 flights of stairs, has a sedentary life-style and uses a Ventolin (Albuterol) inhaler prn. His only known medical condition is hypertension for which he takes Hydrochlorothiazide.

On physical examination he is slightly overweight: 90 Kg., height 170 cm, HR 88, BP 156/90 with an unremarkable upper airway exam. He has mild expiratory wheezing in all lung fields on auscultation and slight clubbing of his finger-tips. No other physical abnormalities are found

Fine needle biopsy showed a non-small cell lung carcinoma. CT scan of the chest shows an obstructive mass 4cm. by 4cm. at the orifice of the right upper lobe and involving the right mainstem bronchus. He is scheduled for bronchoscopy, mediastinoscopy and right pneumonectomy in one week. Past history is otherwise unremarkable.

Questions:

- 1) What respiratory tests are indicated?
- 2) What cardio-vascular work-up is required?
- 3) What other organ system is specifically important to assess in this patient?

Investigations:

Arterial blood gases are within normal limits. FVC is 2.9L (70% predicted), FEV1 is 1.6 L (60%) increasing to 1.9L (72%) post-broncho-dilator.

ECG shows sinus rhythm with occasional PAC's. Creatinine is mildly elevated: 120 μ mol/L (N<100).

Questions:

- 1) What are the parameters for operability in a pneumonectomy candidate?
- 2) What are the most important potential postoperative complications in this patient?
- 3) Does anesthetic management have an impact on any of these complications?
- 4) Are further tests indicated? Which ones?

Further Investigations:

Ventilation/perfusion scanning shows the left/right lung ventilation ratio is 60/40 and the perfusion ratio is 56/44. Exercise testing shows a maximal oxygen consumption of 18 ml/kg/min. Transthoracic echocardiography shows moderate left ventricular hypertrophy with normal systolic function and mild tricuspid regurgitation (estimated RVSP 32). Dipyridamole-thallium myocardial perfusion scanning shows no abnormalities.

Further Investigation or Therapy

1. Should this patient have split-lung function studies?
2. What other medical therapy is indicated?
3. What are the surgical options for this patient?

Intraoperative Management:

- 1) What anesthetic technique would you use?
- 2) What monitors?
- 3) What is the plan for fluid management and why is this so important in this patient?
- 4) What is the plan for ventilation intraoperatively?
- 5) Will this patient need ventilation post-operatively?

Airway management:

After induction of general anesthesia a 41F left double-lumen tube is placed but auscultation shows the tube has entered the right mainstem bronchus.

- 1) What is your initial plan to deal with this complication?
- 2) An attempt to guide the tube into the left-mainstem bronchus with a fiberoptic bronchoscope fails. What are your options?

Cardiac management:

After clamping the right pulmonary artery the patient's ECG shows increasingly frequent PAC's

- 1) What is the importance of this?
- 2) Is treatment indicated and if so what?

Recovery Room Management:

The patient is extubated in the operating room and is transported alert and stable to the recovery room. Over the next two hours the patient remains comfortable but becomes increasingly hypotensive with a low CVP. The hypotension does not respond to fluid boluses or discontinuation of epidural local anesthetic.

- 1) What are the potential causes?
- 2) What are the appropriate investigations?

Postoperative Management:

On a postoperative visit on day 2 you notice that the patient is tachypneic with a saturation of 90% on room air. Chest X-ray shows mild interstitial pulmonary edema in the remaining left lung.

- 1) What is the differential diagnosis?
- 2) In the absence of an obvious cause what therapy is indicated?

PROBLEM BASED LEARNING DISCUSSION

Because the success rates of non-surgical therapy remain so poor, there is tremendous pressure to operate in any patient with a potentially resectable lung malignancy. Improvements in surgical techniques, anesthetic management and perioperative care have expanded the envelope of patients who can be offered surgery. There are now very few patients who have absolute contraindications to pulmonary resection, however, a pneumonectomy in a borderline candidate still demands the utmost respect from the entire medical team.

Pneumonectomy has one of the highest in-hospital mortality rates (5-15%) among common elective operations. This is particularly a problem in the elderly. Factors which correlate with increased morbidity and mortality from pneumonectomy include: intraoperative blood loss, perioperative renal dysfunction, intra-pericardial dissection, COPD and hypertension.

Specific post-operative complications in pneumonectomy patients of concern to the Anesthesiologist include:

- Arrhythmias
- Respiratory failure
- Post-pneumonectomy pulmonary edema
- Cardiac herniation
- Broncho-pleural fistula

Arrhythmias, particularly atrial fibrillation occur post-operatively in 20-25% of pneumonectomy patients and may exceed 40% in patients >70 years of age after right-sided pneumonectomy. Although the ACC/AHA guidelines for preoperative cardiac assessment categorize pneumonectomy as an "Intermediate risk" procedure for cardiac complications, in the elderly this is actually a high-risk procedure. These guidelines suggest that patients who have an exercise tolerance > 4METs (can climb 1 flight of stairs) do not need further cardiac

investigation. However, elderly patients scheduled for pneumonectomy need a minimum of transthoracic echocardiography to assess for elevated right-heart pressures and stress-testing if they do not have excellent (>3 flights) exercise tolerance. Prophylactic Diltiazem has been shown to be useful to decrease the incidence of atrial fibrillation and Amiodarone is useful as additional therapy if fibrillation develops.

Respiratory complications (atelectasis/pneumonia). Although the patient populations are basically the same, there are important differences in the complications associated with pneumonectomy versus lobectomy or lesser resections. The most common causes of morbidity and mortality following lobectomy are respiratory complications, particularly atelectasis and pneumonia. Prediction of post-thoracotomy respiratory complications for any pulmonary resection requires assessment of the preoperative respiratory function in each of the three areas of extra-cellular respiration: lung mechanics, lung parenchymal function and cardiopulmonary interaction (specifically: FEV1, DLCO and exercise tolerance). Based on the amount of functioning lung tissue to be resected, it is possible to predict the post-resection respiratory function. Patients having a pneumonectomy with a predicted post-resection FEV1 or DLCO <40% normal are at elevated respiratory risk and should have a preoperative V/Q scan. Anesthetic management, specifically the use of thoracic epidural analgesia, has decreased the incidence of respiratory complications.

The complication of post-lung resection pulmonary edema is a major concern in pneumonectomy patients but is extremely rare following lesser resections. Post-pneumonectomy pulmonary edema has a very high case-fatality rate (>50%). For reasons which are not clear, the non-operative lung shows an increased micro-vascular permeability after pneumonectomy that is not seen after lobectomy. Although excess perioperative fluids may contribute to this complication, the etiology seems to be multifactorial and severe fluid restriction does not eliminate the problem. Over-distention of the lung during one-lung ventilation should be avoided. Previously recommended tidal volumes for one-lung ventilation (10-12 ml/kg) are excessive and can potentially cause a volume-induced lung injury in the pneumonectomy patient. Also, overdistention of the lung in the post-operative period by displacement of the mediastinum into the operated hemi-thorax should be avoided. This pulmonary edema does not respond to the usual non-specific therapy and aggressive therapy with nitric oxide may be the only treatment that has an effect on this highly lethal complication.

Cardiac herniation is a rare but potentially fatal complication seen in the immediate post-operative period following right-pneumonectomy. An incompletely closed pericardium can permit the heart to herniate and strangulate into the empty right hemi-thorax. This presents as a sudden severe life-threatening hypotension usually on transfer of the patient out of the operating room or in the PACU. The only therapy is immediate re-operation to relieve the strangulation. Cardiac herniation has been reported extremely rarely after left pneumonectomy. Due to the different anatomy of the pericardium on the left, only the apex of the heart herniates and the presentation is of a bizarre sub-acute myocardial ischemia.

A broncho-pleural fistula (dehiscence of the bronchial stump) is a fatal complication if it occurs early in the post-operative period following a pneumonectomy unless it is surgically repaired. The goals of anesthetic management for this complication are: To prevent contamination of the healthy lung from the secretions in the operative hemi-thorax. To prevent development of a

tension pneumothorax during positive pressure ventilation. And, to ensure adequate gas exchange in the ventilated lung in the presence of a low-pressure leak in the airway. To achieve these goals requires placement of a chest drain before induction of anesthesia and lung isolation during anesthesia. Lung isolation can be with a single- or double-lumen endobronchial tube. Ideally, lung isolation should be achieved with the patient breathing spontaneously. In practice this is not always possible and anesthesia induction needs to be modified depending on the status of the patient.

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LEARNING SUMMARY

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